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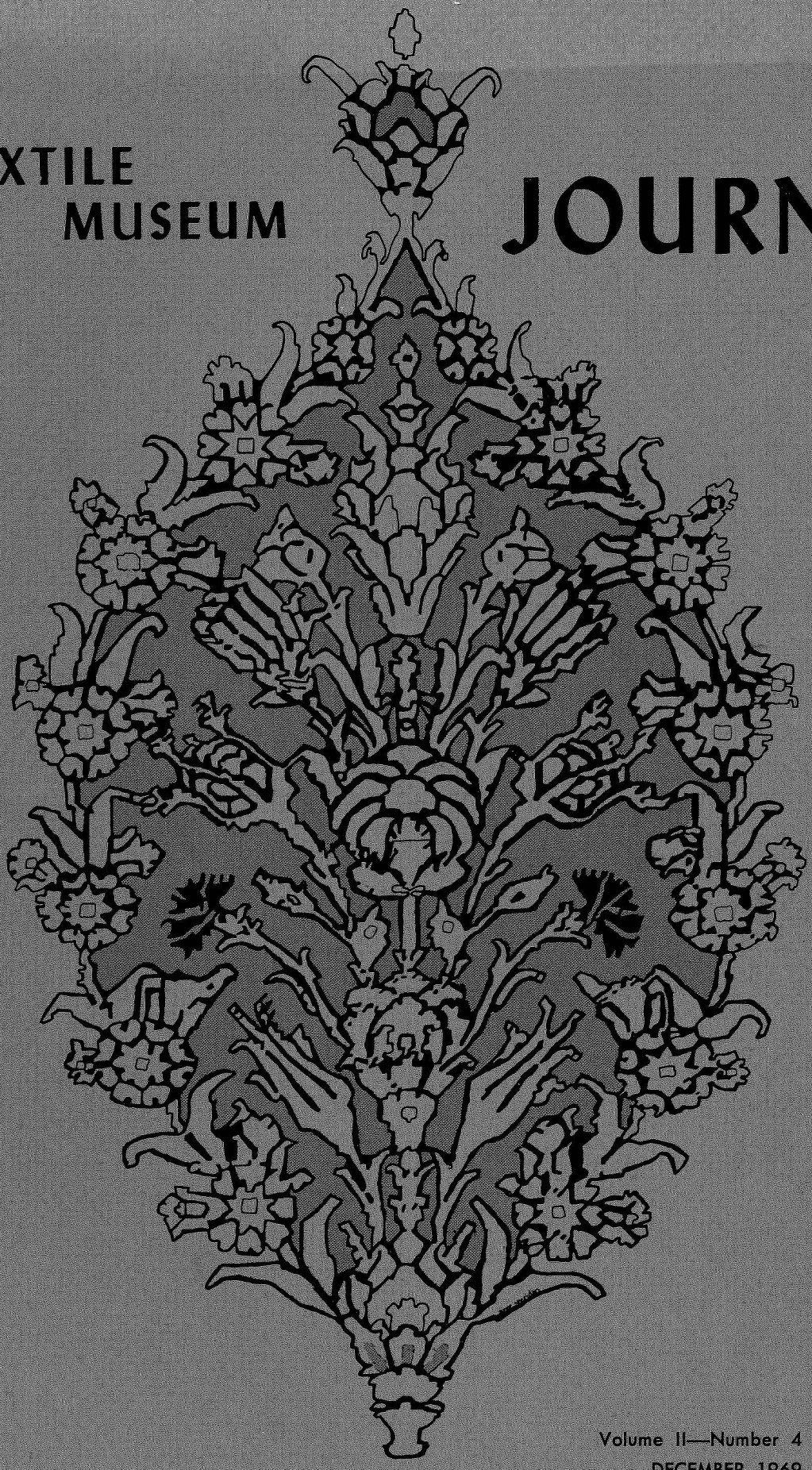
TEXTILE MUSEUM JOURNAL



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COVER: Drawing by Anne Sheridan of the large floral oval wreath designed in the center of Textile Museum's "Benguiat" Ottoman prayer rug, 1967.24.1 (Figure 13 in Charles Grant Ellis' article "The Ottoman Prayer Rugs").

DRAWINGS for Color-relationship Chart and illustrations for "How to Match Colors when Dyeing Yarns or Fabrics for Textile Conservation Purposes" by Col. James W. Rice are by Dianne Sisko.
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PRINCIPLES OF TEXTILE CONSERVATION SCIENCE NO. XII

ADHESIVES FOR TEXTILE CONSERVATION

JAMES W. RICE

What Kind of Adhesives Should We Look for in Conservation of Textiles?

This question has no doubt occurred to most textile conservators. Actually, the answers are not simple, because each individual problem may require a specific adhesive for that particular job. But it seems reasonable to suppose that if we were to assume a condition which according to this author's experience occurs very often in silk, cotton, linen, and wool artifacts, we may imagine a general need. We have in mind a premise wherein the fabric has become so fragile and embrittled that sewing or mending is not feasible but where it must be preserved for display without further damage in treatment.

A great many workers have attempted to solve this problem with flags and other specimens by adhering them to a supporting fabric with adhesives. This has not always been successful.

Perhaps the reason therefor has been a misunderstanding of the principles of adhesion and a lack of knowledge of the behavior of the substances. Thus, in order to provide a basis for making a desision on adhesives for textiles, we offer the following discussion of principles.

When thinking of adhesives, one must remember that they are substances that cause surfaces to stick together. Some special terms included in the general class are glues, pastes, mucilages, gums, cements and bonding agents. In adhesion, the adhesive produces molecular attractive forces between surfaces, often of different composition. A simple picture is that of a sandwich with the adhesive between two layers which may or may not be alike.

Cohesion, a term sometimes encountered, means joining two very close fitting surfaces of the same chemical composition without the help of an intermediate substance. An example is seen where two very clean sheets of plate glass, when pressed together, cannot be separated without damage. The bond between the two surfaces in this case is very strong and is attributed to molecular *at*traction forces. If the surfaces are dirty or do not fit together very closely, the cohesion bond is very much weaker. Except in rare cases, we are not concerned with this phenomenon, although the surface attraction forces must prevail in making a successful bond with an adhesive. Likewise the surfaces must be clean and brought together as closely as possible.

What are Some of the Requirements for Textile Adhesives?

Some of the attributes of a good adhesive are:

1. Its interior molecular forces must be compatible with the molecular forces of both surfaces to be joined.
2. It must be capable of being put into a condition where it can flow between the surfaces to be joined.
3. Under flow conditions, it must be able to wet the surfaces to be joined.
4. When set up, it must produce a strong junction of the flexibility degree necessary between the surfaces.

Specifically, What are some Peculiar Requirements for an Ideal Adhesive for use With Old and Fragile Textiles?

There are five requirements for such an adhesive. For example:

First, a flexible bond between a support and the artifact is almost always necessary.

Second, the bond must be strong and resist both peeling or lateral or lengthwise slippage from stresses and strains.

Third, the adhesive must have a long life so as to resist oxidation or degradation because of aging. This also means that it should not harden or soften or change color with age.

Fourth, it should not have any destructive or damaging effect on the specimen.

Fifth, it should be removable if and when necessary, without changing or damaging the specimen.

In practice, we note four classes of adhesives from the point of view of application. These are:

1. *Solvent sensitive*—where the adhesive in a solvent which may be water or some organic liquid such as acetone, benzene, ether or other less common solvent which when evaporated leaves a solid or a gel behind. Examples are mucilages, pastes, "Duco" ® cement and many other products in common use. This is a familiar technique.
2. *Pressure sensitive*—where the adhesive flows because of increased pressure and adhesion occurs when the pressure is released. This is the principle of masking and surgical tapes which have great resistance to slipping but very little to peeling.
3. *Temperature sensitive*—in this case flow and wetting is increased by raising the temperature and

solidification or gelling occurs on cooling. Asphalt road mending materials are of this class.

4. *Chemical reaction sensitive*—this involves the use of low molecular weight reactants which are fluid in that condition and which, as a result of later chemical action, including polymerization, causes the molecules to change in chemical state and join. As the molecules grow in size or length by cross linking, a very strong bond is formed. Some of the modern Epoxy cements are of this class. The polymerization reaction is often triggered by another substance called a catalyst which greatly increases the rate of the reaction.

Sometimes the individual problems will demand an adhesive that will fall into more than one of these classes. For example, we may have occasion to apply an adhesive in solution and then by subsequent treatments produce the final bond. Inner tube mending patching is one of these. We first clean the tire surface. This is important in any bonding operation. Then, next we spread a rubber cement which is a solution of uncured rubber in a solvent. The uncured rubber is of lower molecular weight than that of the tire and the solvent helps the cement to penetrate into the tire surface. At this time the bond is not very strong. After a few minutes of drying, the patch, which is of uncured rubber and a catalyst, is applied. The patched and mended area is heated, at which time the uncured rubber vulcanizes or sets up and the mended area polymerizes to the same molecular condition as the tube. This provides the strongest possible bond. A thin coating of the cement gives the best bond.

We have two main classes of adhesives if we consider the basis of origin. These are the natural and the synthetic or man-made. In the natural category, we find the protein glues either the animal or the vegetable. Hides, bones, sinews, blood and casein are the usual animal substances that are used in making these. Vegetable glues are made from soya beans and grain germs. Seeds, grains, and resins form the vegetable mucilages and gums. Shellac, and natural rubber are others.

Sodium silicate is probably the most prominent inorganic adhesive that finds wide application in the manufacture of corrugated paper containers.

Asphalt is another widely used mineral substance.

With a few exceptions, most of the natural substances have objectionable features such as uncontrollable brittleness and dark color development as they age. In time some lose their adhesiveness. The sodium silicate mentioned above is used in great quantities in making paper boxes but it cannot be used generally on textiles because it is quite alkaline and might destroy wool or silk.

The synthetic group may be divided further into two sub-classes, the thermoplastic and the thermosetting types. The thermoplastic adhesives can be melted and made to flow. Upon cooling, they resolidify or regel. On the other hand, the thermosetting types polymerize or set up more strongly as the temperature rises.

Cellulose esters (similar to Duco ®), cellulose ethers (such as carboxymethyl cellulose), acrylic esters, polyamids (like Nylon), polystyrene (like transparent buttons), polyvinyl alcohols and others are examples of the thermoplastic group.

The thermosetting resins and adhesives are combinations of urea, melamine, phenol, resorcinol, furfural, epoxy and polyester substances.

Many of the adhesives in either division are unsuitable because they discolor with age and continue to harden beyond a satisfactory state.

Among the thermoplastic types, polystyrene and polyvinyl-alcohol compounds promise the best results for museum work. This is because they are clear and can be used at relatively safe temperatures.

The thermosetting types can be solidified at relatively low, safe temperatures by the judicious employment of catalysts and redox reagents, pH and time conditions.

The surface that we may be working with and the final product that we hope to achieve have a great bearing on our choice of adhesive. If the surfaces are the same material, then we should use an adhesive that will dry or cure finally into the same hardness, as co-efficient of expansion and flexibility as the two substrates. If they are different materials, we must choose one that will adhere tenaciously to both surfaces, yet have sufficient internal mobility and flow to permit unequal expansion.

There are two ways of accomplishing this flexibility. First, we may mix an additive into the adhesive which will prevent complete drying. Sometimes these additives are merely internal lubricants. Second, we may arrest the chemical reaction before it goes to completion. On occasion, we may add substances to the mixture to interfere with the reaction. These are in a sense negative catalysts. Or we may keep the temperature down so that the reaction rate is very, very slow. Chemicals used to control stiffness are generally called plasticizers. Those for slowing down the reaction are called inhibitors.

With this much too brief and elementary review of the theory of adhesives as a background, we offer the following advice as to how to choose an adhesive for textiles. In doing so, you should know the answers to most of the following questions:

1. What original fabric is involved? Is it wool, cotton, silk, linen, paper, or leather? In selecting a compatible adhesive, we consider glues or gelatins for wool, silk, or leather. Polyamids should also be considered. For cotton, linen and paper, starch or mucilages may be the selection.

2. What support is to be used? Is it silk, wool, cotton, linen, paper, jute, plastic, or synthetic fiber? Compatibility both with adhesive and the specimen to be displayed is important.

3. What is the condition of the original fabric? Will it withstand flexing and to what degree? If afterwards it is to be draped, we must seek a plasticized adhesive which has sufficient strength to support the garment on hanging.

4. Should the specimen be immobilized? Often the physical condition of the object is such that it is powdering. In that case, a hard transparent adhesive may be needed.

5. What temperature will the specimen withstand? This will tell you whether you may employ a thermoplastic type.

6. Will it ever be desirable to remove the adhesive? In such a case, one might select a solvent sensitive adhesive.

7. Can you permit a color change or darkening of the adhesive? Since many of the better adhesives will change color in light of blue and violet wave lengths and where the specimen may be exposed to such conditions, a careful selection of the adhesive in this regard may be necessary.

8. What are other conditions of storage and display that the adhesive must resist? The humidity, temperature changes and other factors may affect the adhesive over a long period of time.

From the point of view of ethics, this writer believes that for most textile conservation problems, adhesives should be used only for transitory purposes such as holding two pieces of fabric together while sewing or reweaving. After such an operation the adhesive should be removed. In this case, the adhesive must be completely soluble in a solvent that does not affect the textile later.

With this in mind, our experiences have been limited to a few that combine temporary adhesion with solubility in solvents later that can be safely applied to the artifact.

Col. Rice conducting a special class in Conservation Techniques and Chemistry.

Col. James W. Rice with visitors on a tour through the Museum Laboratory.